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COMPARATIVE ANALYSIS OF GOOGLE EARTH DERIVED ELEVATION WITH IN-SITU TOTAL STATION METHOD FOR ENGINEERING CONSTRUCTIONS

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INTRODUCTION

- Physical & Infrastructural Development compulsorily require:
  - Information about the Earth's topography
  - Height/Elevation of the bare earth
- Such data is used for construction of:
  - Road, Rail, Bridges, Dams etc
- And other scientific studies

INTRODUCTION (Cont'd)

- Google Earth (G.E.) data offers an alternative amidst other satellite derived elevations sources
- G.E. data:
  - Easy to access
  - Readily available
  - May replace traditional methods of height determination measurement (levelling); with improved accuracy.

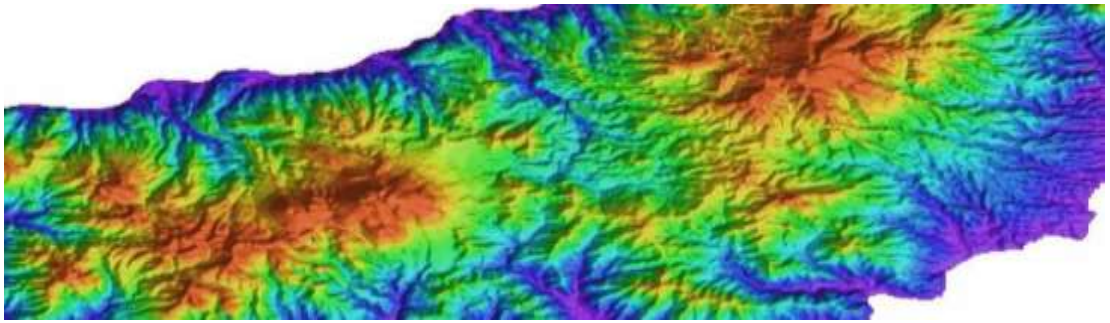
INTRODUCTION (Cont'd)

Relevant questions by users and potential users

- What are the size of errors inherent in the data?
  - Globally
  - Locally (Aba, Nigeria)
- How useful is G.E. height ?
- To what extent can G.E. height be used the given the level of error in it?

INTRODUCTION (MOTIVATION)

- No report of the global accuracy of G. E. elevation available in public domain
- Only one research so far conducted in Nigeria (Richard & Ogba, 2017)
  - Focused on the morphometric potential without assessing the altimetric quality of G.E. data.



Materials & Methods (Area of Study)

- The study area is at Aba metropolis in Abia State Nigeria
- A low-lying land south-East of
- Nigeria located between:
  - ***7°23'41.99" - 7°27'32.85"E***
  - ***5°09'11.49"- 5°11'34.82"N***

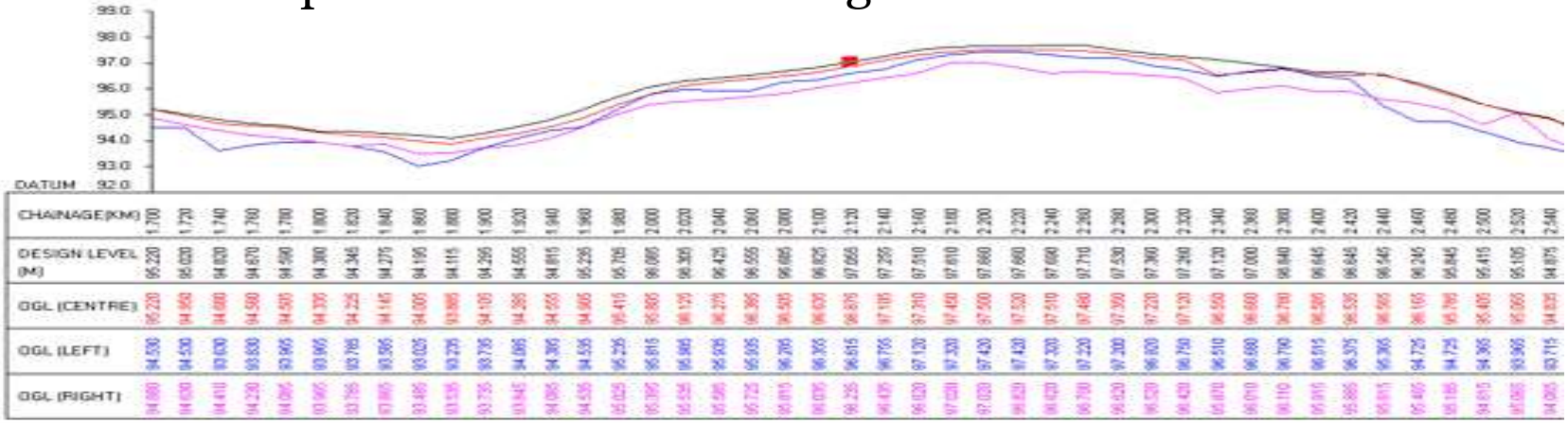
Materials & Methods (Tools)

S/No	Software	Remark
1	ESRI ArcGIS 10.5	Used for plotting and conversion of points to KML format
2	SPSS version 23	Used for statistical analysis
3	TCX	For extraction and update of height of points
4	Google Earth Pro	Platform for obtaining G.E. elevation data
5	Microsoft Excel	For data organization and profile plotting

Materials & Methods (Data)

- Longitudinal Profile of a road

- Extracted equivalent from G. E. using TCX



Materials & Methods
Accuracy & Similarity indicators

- Accuracy indicators
  - Mean Error (ME)
  - Root Mean Square Error (RMSE)
  - Standard Deviation (Std Dev)
  - Mean Absolute Deviation

- *Similarity indicators*
  - *Correlation analysis (Pearson)*
  - *Non-parametric correlation analysis*
    - *Spearman*
    - *Kendall's tau*
  - *Mann-Whitney U*
  - *T-Test*

Materials & Methods
"Usefulness" indicators

Category of accuracy	Standards
Rough Leveling	Statutory Criterion
Ordinary Leveling	Statutory Criterion
Accurate Leveling	Statutory Criterion
Precise Leveling	Statutory Criterion

RESULTS & OBSERVATIONS

Both heights show some level of similarity:

•They both report slightly varying range, mean, minimum & maximum height value

One may (at this point), want to conclude that clear distinction exist between the two elevations

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Total Station Height (m)	412	15.295	70.687	85.982	78.67075	5.152215
Google Earth Height	412	17	72	89	80.318	4.5646

RESULTS & OBSERVATIONS (Cont'd)

The table shows the descriptive statistics of the results from the basic comparison between height from G.E. and Total station.

In general it can be said that G.E. data overestimates the topography of the profile by an average and maximum value of 1.65m and 8.89m respectively.

The positive mean error value indicates that majority of the errors are greater than zero. (supported by MAD Value "immune" to extreme values)

Therefore G.E. height values may be said to be positively biased along the profile path.

DESCRIPTIVE STATISTICS	VALUE
Mean	1.6472
Std. Error of Mean	0.1116
Median	1.5925
Std. Deviation	2.2661
Minimum	-5.295
Maximum	8.888
RMSE	2.7993
Median Absolute Deviation	1.7155

RESULTS & OBSERVATIONS (Cont'd)

Questions by users:

•How much similarity exists between the two datasets?

•How significant is this similarity

Pearson's value of 0.899 @ 0.01 level of significance indicates existence of a significant positive relationship

Kendall's tau and Spearman's rho; respective values of 0.705 and 0.878(@ 0.01 level of significance), indicate a significant relationship between datasets

Total Station Vs Google Earth Height Value	
Parametric	
Test	Value @ 0.01 level of significance
Pearson's	0.889
Non-Parametric	
Test	Value @ 0.01 level of significance
Kendall's Tau	0.705
Spearman's rho	0.878

RESULTS & OBSERVATIONS (Cont'd)

Judging by ρ (Sig) value, It is safe to state that *a statistically significant difference exist between the two datasets*

Total Station Height Value Vs Google Earth Height Value	
Assumption of Normal Distribution	
Test	ρ (Sig) value
t-Test for Equality of Means	0.000
Without Assumption of Normal Distribution	
Test	ρ (Sig) value
Mann-Whitney U	0.000

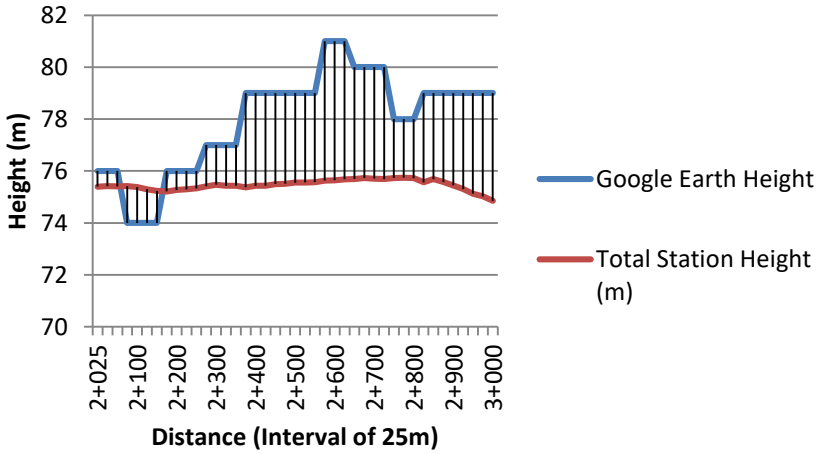
Implication/Usefulness based on Inherent error

Different categories of accuracy for levelling operation					
	Rough Leveling	Ordinary Leveling	Accurate Leveling	Precise Leveling	Total Length (km)
Constant value	0.1	0.024	0.01	0.005	10.125
Accuracy (m)	0.318	0.076	0.032	0.016	

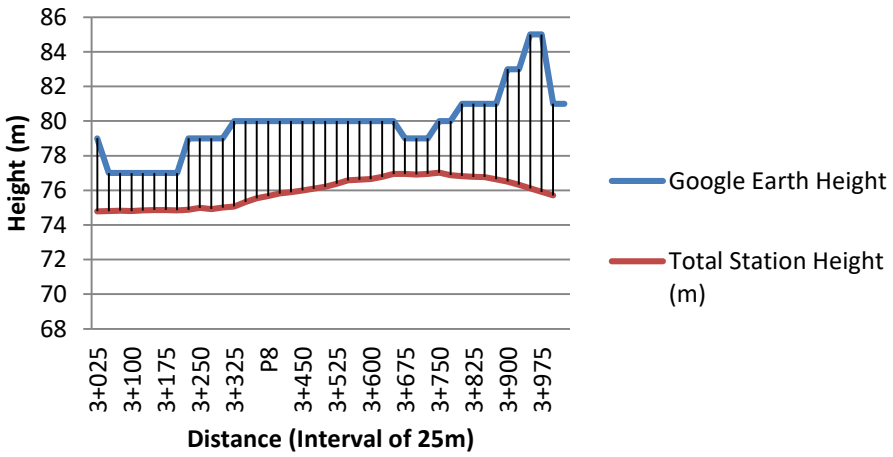
Judging by the Mean Error and RMSE value of 1.65m and 2.79m (table 3.0) of the dataset, the G.E. height cannot be used as a sufficient replacement of heights obtained by conventional levelling method

Profiles

Third Km Profile



Fourth Km Profile



CONCLUSION

- Datasets look similar: "*Prima Facie*"
- But *significantly* different from the perspective of "*Robust & Rigorous*" statistics
- G. E. height data *failed to meet minimum standard* for levelling data
  - Therefore, *cannot and should not* be used for planning and executing serious engineering projects, particularly within study area (Aba).

THANKS FOR YOUR AUDIENCE